

# Exploring the adequacy of representation of butterfly species' distributions in a more accessible portion of northern Australia

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## Abstract

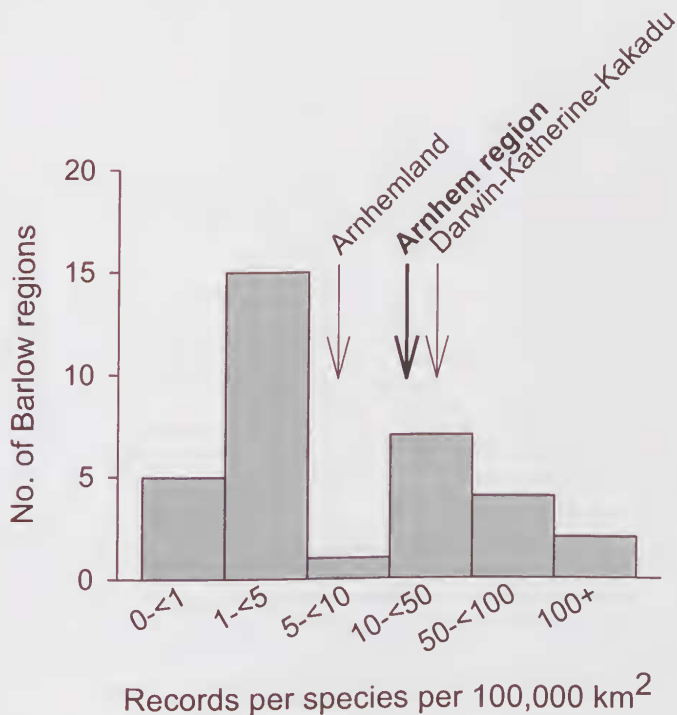
Results of a 13-day field survey of butterflies in the Darwin – Katherine – Kakadu area in 2008 are compared with existing synoptic maps and a private national database of butterfly records. Ten records of four species are beyond distributions previously mapped for them. The most substantial extensions (> 200 km) are for a species (*Cepbrenes augiades*) that may be expanding its range and another (*Nacaduba biocellata*) that may be subject to large-scale seasonal irruptions. The Darwin – Katherine – Kakadu area has been moderately surveyed by Australian standards but has only one record of each species per 3,700 km<sup>2</sup>. Whilst it is likely that national synoptic maps of species' distributions represent the ranges of most species reasonably accurately, much remains to be learnt about butterfly distributions in the region.

Knowledge of the distribution and range size (“Extent of Occurrence” and “Area of Occupancy”) of species is fundamental to defining their niche and identifying biogeographic patterns (Brown *et al.* 1996; Gaston 2003). In addition, geographic range is a key attribute used in conservation assessment (IUCN 2003; Baillie *et al.* 2004; Gaston & Fuller 2009). With reference to Australian butterflies, Sands and New (2002, p.10) stated that IUCN Criterion B – geographic range – “is the most useful criterion for butterflies” because information about other criteria such as the size, trend and dynamics of populations is available for very few taxa.

The benchmark distribution maps for Australian butterfly species are those of Braby (2000), reproduced at smaller scale and with minor modification in Braby (2004). These maps are synoptic interpretations of information collected by both amateur and professional entomologists, much of which was entered into a database by Dunn and Dunn (1991). The history, data composition (completeness, representativeness) and quality assurance processes of this database have been discussed earlier (Dunn & Dunn 2006; Dunn 2009a,b, 2010). Although holdings now exceed 132,000 records (Appendix), documentation of the distribution of Australian butterflies remains limited by the exceedingly uneven sampling in many areas of the continent (Figure 1).

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The question thus arises: how well documented need the butterfly fauna be before we can have reasonable confidence that regional patterns of occurrence have been adequately described to the extent that additional surveys rarely require adjustment of synoptic maps?



**Figure 1.** Intensity of records of butterfly species for the 33 Barlow regions in Australia (Barlow 1985), from the Dunn & Dunn database (1991, with updates to 2008). The relative intensity of recording in the Arnhem region (bold font and arrow) and two sub-regions within it (not bold) are shown. Data underlying the graph are presented in the on-line Appendix.

In this study, we report an evaluation of the ability of existing records and synopses to represent the range of species in the Darwin – Katherine – Kakadu area of northern Australia by comparing these with the results of a 13-day field survey conducted early in the dry season. The area is remote from the major settlements in southern Australia, but has population centres in Darwin and Katherine and, in recent decades, good road access that has made it a focus for visitors. The area is moderately surveyed by Australian standards, with an average of 27.0 records per 100,000 km<sup>2</sup> (which equates to one record per species per 3,700 km<sup>2</sup>) (Figure 1 and Appendix). The

Darwin – Katherine – Kakadu area is part of the Arnhem region of northern Australia as defined by Barlow (1985) – the Top End of the Northern Territory north of 15° South. The region comprises a matrix of higher-rainfall tropical savanna (mean annual rainfall of *c.* 800–2,000 mm yr<sup>-1</sup>) embedded with patches of monsoon forest, mangroves, riparian forest and other habitats (Woinarski *et al.* 2007). Typical of tropical savanna environments, the rainfall is strongly seasonal, with *c.* 90% falling in the six months from November to April inclusive (McDonald & McAlpine 1991). The main population centres are Darwin (population 110,000) and Katherine (10,000). These centres, some smaller settlements and the World Heritage-listed Kakadu National Park, all in the west of the Arnhem region, are serviced by sealed roads. In contrast, the north-eastern section of the Arnhem region comprises the Aboriginal reserve known as Arnhemland, which lacks sealed access roads and to which entry is restricted to residents and permit holders.

Butterflies were surveyed by one of us (KLD) in the Darwin – Katherine – Kakadu area over 13 days commencing 27 May 2008. Sites were selected along sealed roads from Mataranka to Darwin including Daly River, and east to Cahill's Crossing in Kakadu National Park. They were selected on an *ad hoc* basis and to be at least *c.* 2 km apart and to represent a range of vegetation types, with particular emphasis on river crossings and areas enriched with blossoming trees that may attract butterflies. Sites were surveyed between 0900 and 1730 hours. At each site, a transect of approximately 300–1,000 m or an area of *c.* 200 m<sup>2</sup> was surveyed for from 10 minutes to 3.3 hours (mean = 40 minutes). Butterflies were identified visually as free-flying adults or by netting, particularly those taxa that required detailed examination (e.g. Hesperiiidae and Lycaenidae). In conservation reserves, where netting is prohibited without a permit, visual identification was augmented with video photography and identification of road kills. At the end of the observation period, a list of all species recorded was compiled for each site.

Each record was the occurrence of a species at a site. Records were compared with the synoptic maps of Braby (2000) and records in the private database of Dunn and Dunn as updated to 2008 (prior to the field survey) to identify locations beyond those already mapped.

During the field survey, 83 sites were surveyed, 716 records were obtained and 73 species identified in 51.2 hours of observation. Ten records (1.4%) of four species (5.5%) fell beyond previously documented ranges (Table 1), suggesting that current synoptic maps depict well the broad-scale pattern of occurrence of most species, but not all, for this region of northern Australia. Three of these four species were recorded at one extralimital location each, with range extensions of from about 40 to 220 km (Table 1). The fourth species, *Nacaduba biocellata*, was recorded at seven extralimital locations.

The range extensions documented for two species in this study, *Borbo impar* and *Elodina padusa*, are relatively minor at about 40 and 70 km, respectively. However,

**Table 1.** Butterfly records in the Darwin – Katherine – Kakadu area from May-June 2008 that fall outside previously documented distributions. VS = Voucher specimen retained; ANIC = Australian National Insect Collection; KLDC = KLD's collection.

Species	Date	Location	Notes
<i>Cephrènes augiades</i> (Orange Palm-dart)	4 June	near Cahill's Crossing, East Alligator River, Kakadu NP (12°24'S, 132°58'E)	Male photographed; shelters with larvae located. This is c. 225 km east of records from urban Darwin (for more details, see Dunn 2009c).
<i>Borbo impar</i> (Yellow Swift)	29 May	bank of Daly River, opposite Daly River Police Station (13°46'S, 130°43'E)	Male netted (VS: KLDC). A south-western extension of range of c. 73 km from Adelaide River (record in Angel 1951).
<i>Elodina padusa</i> (Narrow-winged Pearl-white)	31 May	12 km north-east of Pine Creek (13°46'S, 131°48'E)	Male netted at flowering Turkeybush <i>Calytrix</i> <i>exstipulata</i> (VS: KLDC). This is c. 40 km NNW of a record from the Cullen River (Braby 2000) and c. 120 km east of a record from "Daly River" (Le Souëf 1971).
<i>Nacaduba biocellata</i> (Two-spotted Line-blue)	30 May	Stuart Highway 46km SE of Katherine (14°39'S, 132°38'E)	Several adults present; one netted (VS: ANIC).
	30 May	Stuart Highway 42km SE of Katherine (King River Crossing; 14°32'S, 132°36'E)	Several adults present; one netted (VS: ANIC).
	31 May	15.5km SW of Coinda turn off, Kakadu NP (13°01'S, 132°28'E)	One male, perched on Turkeybush
	1 June	40 km by road SW of Jabiru, Kakadu NP (12°53'S, 132°39'E)	One male, feeding at flowers of Turkeybush
	1 June	Nawurlandja Lookout, Kakadu NP (12°52'S, 132°47'E)	Two adults, one photographed*; also one adult seen on 3 June
	1 June	Nourlangie Rock carpark, Kakadu NP (12°52'S, 132°49'E)	One adult feeding at flowers of <i>Tridax procumbens</i> (Asteraceae)
	2 June	Muirella Park, Kakadu NP (12°57'S, 132°45'E)	One adult feeding at flowers of Turkeybush

\* This photograph was provided to the editor and referee as proof of identity.

considerable uncertainty in the precision of the historical locations, and thus in the estimation of range extensions, is applicable. Historically, collecting sites may have been described relatively inaccurately by today's standards or be subject to somewhat different interpretation because landscape nomenclature has changed over time. Of necessity, we have interpreted the locations literally, consistent with previous practice (Busby 1979). In contrast, the more substantial and more accurately known range extension for *Cephrenes augiades* suggests that this species may well be expanding its range into suitable bushland habitat. The species was possibly introduced to northern Australia relatively recently with the importation of exotic palms (its larval food plant), being first detected in urban Darwin in 1991 (DN Wilson in Braby 2000). This range expansion is consistent with several recent non-urban records in the Darwin area (Franklin 2009).

*Nacaduba biocellata* was previously recorded primarily from the southern two-thirds of the continent, extending northwards on the east coast to Cape York and in the Northern Territory to the Tanami Desert and southern Barkly Tableland, with outlying records in the Kimberley and at Darwin (Braby 2000). As well as in Kakadu National Park (this survey), it has since been recorded in numbers from the hinterland of the Gulf of Carpentaria in July 2006 and at four sites in Keep River National Park in July 2010 (Franklin 2007; DCF pers. obs.). Records of this species further north include a single specimen collected at Lameroo Beach (Darwin) in August 1979 (Australian National Insect Collection), and an unpublished observation from East Point (Darwin) in March 2003 (DCF). Other records of this species from many additional locations in northern Australia are held in the collections of the Northern Territory Museum and the Biodiversity Conservation (Northern Territory Government) database (M. Braby, pers. comm.). However, *N. biocellata* was not recorded in a recent extensive survey of the Darwin area (Meyer *et al.* 2006). Despite the five records from Kakadu National Park reported in this paper, extensive surveys in the Park in recent years (2003-2009) have not yielded any further records of the species (DCF, unpublished data). The status of *N. biocellata* in monsoonal northern Australia, including in particular whether appearances are seasonal and whether breeding occurs regularly, irregularly or at all, warrants further investigation. Whilst it is possible that the species breeds well north of the previously recorded distribution as presented by Braby (2000), we suggest that *N. biocellata* is at most an infrequent, irruptive visitor to the higher rainfall parts of the Top End of the Northern Territory such as Darwin and Kakadu.

Our results confirm that much remains to be learnt about the distribution of Australian butterflies. A limited field survey of an area that is relatively well surveyed by Australian standards recorded ten new locality records for four species, with two in excess of 200 km. However, these latter records were for one species that may be expanding its range, and the other for a species that may be subject to large-scale seasonal irruptions. To put our findings in context, for substantial portions of the Australian continent *any* butterfly record is likely to be more than 100 km from any

previous record. The less surveyed areas are concentrated in the vast semi-arid zone of the centre and west (Appendix). As well as being remote and relatively inaccessible, low species diversity in these regions poses a significant disincentive to butterfly enthusiasts and professional lepidopterists (Dunn 2009b). In the preparation of synoptic maps, this paucity has doubtless been partly compensated for by more extensive interpolation in areas with fewer records.

Nevertheless, our findings reinforce the fact that extrapolation from synoptic maps to the assessment of specific areas, such as for environmental impact assessment and evaluation of management issues for conservation reserves, is no substitute for further field surveys. Furthermore, the distribution of available records is likely to be geographically and taxonomically very uneven within the area. It also highlights the tantalising possibility that the geographic range of rare taxa in the area may be larger, perhaps even considerably so, than is currently understood, particularly so for cryptic species.

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## Appendix.

Number of butterfly records per species in the Barlow regions of mainland Australia and Tasmania (data from Dunn and Dunn 1991, updated to 2008).

This appendix is available at: <http://sites.google.com/site/ntfieldnaturalists/journal>.



The Two-spotted Line-blue *Nacaduba biocellata* was recorded at seven locations in the Katherine and Kakadu areas. (Kelvyn Dunn)